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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/605,442	06/28/2000	Leon R. Barstad	50439-2	5430
21874	7590	09/29/2004	EXAMINER	
EDWARDS & ANGELL, LLP P.O. BOX 55874 BOSTON, MA 02205			WILKINS III, HARRY D	
			ART UNIT	PAPER NUMBER
			1742	
DATE MAILED: 09/29/2004				

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b> 09/605,442	<b>Applicant(s)</b> BARSTAD ET AL.	
	<b>Examiner</b> Harry D Wilkins, III	<b>Art Unit</b> 1742	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

#### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 03 August 2004.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 124-137 and 140-153 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 124-137 and 140-153 is/are rejected.
- 7) ☒ Claim(s) 140 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 28 June 2000 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |                                                                                                                        |                                                                                         |
|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)                                            | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____                                                |

### **DETAILED ACTION**

1. The previous grounds of rejection based on Andricacos et al (US 6,709,562) have been withdrawn in view of Applicant's remarks regarding the uncertainty of the actual amount of brightener added to the solution.
2. However, new grounds of rejection are presented below.

### ***Claim Objections***

3. Claim 140 is objected to because of the following informalities: this claim recites "bissulfopropyl" while the specification recites "bissulfonopropyl" (page 10, line 12). Appropriate correction is required, whether it be to amend the claim or the specification to agree.

### ***Claim Rejections - 35 USC § 102***

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 124-132, 135 and 136 are rejected under 35 U.S.C. 102(e) as being anticipated by Dubin et al (US 5,972,192).

Dubin et al anticipate the invention as claimed. Dubin et al teach (see abstract, col. 4, lines 42-54, col. 7, line 58-col. 8, line 16 and col. 9, lines 9-22) a method for

Art Unit: 1742

plating/depositing copper onto a semiconductor wafer having vias or trenches from an electroplating solution that contains a soluble copper salt (copper sulfate), an electrolyte (water) and one or more brighteners having a molecular weight of about 1000 or less (2,5-dimercapto-1,3,4-thiodiazol) that are present at at least 1.5 mg per liter of the solution (brightener added at 0.5 to 30 mL/L of solution, thus, inherently more than 1.5 mg/L).

Regarding claims 125-132, the disclosure of 30 mL/L inherently reads on more than 15 mg/L.

Regarding claim 135, Dubin et al teach (see col. 7, line 63) a source of  $\text{Cl}^-$  ions.

Regarding claim 136, while Dubin et al do not expressly teach electrically attaching the silicon wafer to the cathode, due to the underlying electrochemical reaction, the wafer is inherently connected to the cathode. This is also shown to be well known in the art by other art of record.

6. Claims 124-132, 135 and 136 are rejected under 35 U.S.C. 102(e) as being anticipated by Uzoh (US 6,117,784).

Uzoh anticipates the invention as claimed. Uzoh teaches (see abstract and col. 3, line 38 to col. 4, line 9) a method of plating/depositing copper on a semiconductor wafer having vias or trenches from an electroplating solution that contains a soluble copper salt ( $\text{CuSO}_4$ ), an electrolyte (water) and one or more organic brighteners having a molecular weight of about 400 to 1000 that are present at 0.5 to 1.25 wt% of the solution (1.25 wt% = 12.5 g brightener per 1 kg water = 10L water = 1250 mg/L).

Regarding claims 125-132, Uzoh teaches adding the organic brightener at up to 1250 mg/L.

Regarding claim 135, Uzoh teaches (see col. 3, lines 61-63) adding 30-70 ppm Cl<sup>-</sup> ions.

Regarding claim 136, Uzoh teaches (see col. 4, line 13) that the substrate is engaged as the cathode.

***Claim Rejections - 35 USC § 103***

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 137, 141-149, 152 and 153 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al (US 5,972,192) in view of Dahms et al (US 3,778,357).

Dubin et al teach the invention substantially as claimed as described above.

However, Dubin et al do not teach that the brightener is a compound having the general formula R'-S-R-SO<sub>3</sub>X as is presently claimed.

Dahms et al teach (see abstract, col. 4, lines 5-45 and col. 6, lines 9-20) a preferred embodiment for the electroplating of copper using sodium 3-mercaptopropane-1-sulfonate (HS(CH<sub>2</sub>)<sub>3</sub>SO<sub>3</sub>Na) and that the divalent sulfur compound allows for high brightness deposition of copper which is free from haze.

Therefore, it would have been obvious to one of ordinary skill in the art to have used the sodium 3-mercaptopropane-1-sulfonate of Dahms et al for the brightener of

Art Unit: 1742

Dubin et al because Dahms et al teach that the divalent sulfur compound improves brightness and produces a copper electrodeposit free from haze.

Regarding claim 141, the sodium 3-mercaptopropane-1-sulfonate ( $\text{HS}(\text{CH}_2)_3\text{SO}_3\text{Na}$ ) has a molecular weight of 170.

Regarding claims 142-149, the disclosure of 30 mL/L inherently reads on more than 15 mg/L.

Regarding claim 152, Dubin et al teach (see col. 7, line 63) a source of  $\text{Cl}^-$  ions.

Regarding claim 153, while Dubin et al do not expressly teach electrically attaching the silicon wafer to the cathode, due to the underlying electrochemical reaction, the wafer is inherently connected to the cathode. This is also shown to be well known in the art by other art of record.

9. Claims 137, 141-149, 152 and 153 are rejected under 35 U.S.C. 103(a) as being unpatentable over Uzoh (US 6,117,784) in view of Dahms et al (US 3,778,357).

Uzoh teaches the invention substantially as claimed as described above.

However, Uzoh does not teach that the brightener is a compound having the general formula  $\text{R}'\text{-S-R-SO}_3\text{X}$  as is presently claimed.

Dahms et al teach (see abstract, col. 4, lines 5-45 and col. 6, lines 9-20) a preferred embodiment for the electroplating of copper using sodium 3-mercaptopropane-1-sulfonate ( $\text{HS}(\text{CH}_2)_3\text{SO}_3\text{Na}$ ) and that the divalent sulfur compound allows for high brightness deposition of copper which is free from haze.

Therefore, it would have been obvious to one of ordinary skill in the art to have used the sodium 3-mercaptopropane-1-sulfonate of Dahms et al for the organic

brightener of Uzoh because Dahms et al teach that the divalent sulfur compound improves brightness and produces a copper electrodeposit free from haze.

Regarding claim 141, the sodium 3-mercaptopropane-1-sulfonate ( $\text{HS}(\text{CH}_2)_3\text{SO}_3\text{Na}$ ) has a molecular weight of 170.

Regarding claims 14-149, Uzoh teaches adding the organic brightener at up to 1250 mg/L.

Regarding claim 152, Uzoh teaches (see col. 3, lines 61-63) adding 30-70 ppm  $\text{Cl}^-$  ions.

Regarding claim 153, Uzoh teaches (see col. 4, line 13) that the substrate is engaged as the cathode.

10. Claims 124-132, 135-137, 141-149, 152 and 153 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dahms et al (US 3,778,357) in view of Dubin et al (US 5,972,192).

Dahms et al teach the invention substantially as claimed. Dahms et al teach (see abstract, col. 3, lines 44-55 and col. 4, lines 5-45) a method of electroplating copper onto a substrate including a soluble salt of copper (copper sulfate), a source of chloride ions and a brightener, such as sodium 3-mercaptopropane-1-sulfonate ( $\text{HS}(\text{CH}_2)_3\text{SO}_3\text{Na}$ ), at 0.0005 to 0.2 g/L = 0.5-200 mg/L. Thus, Dahms et al teach adding the brightening agent at up to 200 mg/L.

Thus, Dahms et al fails to teach plating on a semiconductor wafer substrate.

Dubin et al teach (see col. 1, lines 5-40) electroplating copper onto a dielectric silicon layer of a microchip wafer with microvias and trenches.

Therefore, it would have been obvious to one of ordinary skill in the art to have applied the copper electroplating method of Dahms et al to the silicon microchip wafer with microvias and trenches of Dubin et al because the method of Dahms et al has improved throwing power (abstract), thus indicating improved ability to evenly fill high aspect ratio surface features such as the microvias and trenches of Dubin et al.

Regarding claims 125-132 and 142-149, Dahms et al teach adding the brightening agent at up to 200 mg/L.

Regarding claim 141, the sodium 3-mercaptopropane-1-sulfonate ( $\text{HS}(\text{CH}_2)_3\text{SO}_3\text{Na}$ ) has a molecular weight of 170.

Regarding claims 135 and 152, Dahms et al teach (see col. 4, lines 54-56) adding a source of chloride ions.

Regarding claims 136 and 153, Dahms et al teach (see Example 2) using the substrate as the cathode (i.e.-electrically connected to the cathode).

11. Claims 124-132 and 136 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lyde (US 3,674,660) in view of Dubin et al (US 5,972,192).

Lyde teaches the invention substantially as claimed. Lyde teaches (see abstract, col. 2, lines 35-49 and col. 2, line 74 to col. 3, line 33) a method of electroplating copper onto a substrate including a soluble salt of copper (copper pyrophosphate) and a brightener, such as 2,5-mercapto-1,3,4-thiadiazole at more than 1 mg/L.

Thus, Lyde fails to teach plating on a semiconductor wafer substrate.

Dubin et al teach (see col. 1, lines 5-40) electroplating copper onto a dielectric silicon layer of a microchip wafer with microvias and trenches.



Therefore, it would have been obvious to one of ordinary skill in the art to have applied the copper electroplating method of Lyde to the silicon microchip wafer with microvias and trenches of Dubin et al because the method of Lyde has improved inhibition of step plating (inconsistencies of plating at surface features) and leveling power (col. 1, line 74-col. 2, line 9), thus indicating improved ability to evenly plate copper even near surface features such as the high aspect ratio microvias and trenches of Dubin et al.

Regarding claims 125-132, Lyde teaches adding the brightening agent at more than 1 mg/L. This includes the entire claimed range. It would have been obvious to one of ordinary skill in the art to have increased the amount of brightener to have optimized the improved inhibition of step plating and leveling power.

Regarding claim 136, while Lyde does not expressly teach electrically attaching the silicon wafer to the cathode, due to the underlying electrochemical reaction, the wafer is inherently connected to the cathode. This is also shown to be well known in the art by other art of record.

12. Claims 137, 141-149 and 153 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lyde (US 3,674,660) in view of Dubin et al (US 5,972,192) as applied to claims 124-132 and 136 above, and further in view of Dahms et al (US 3,778,357).

Lyde in view of Dubin et al teach the invention substantially as claimed as described above.

However, Lyde in view of Dubin et al do not teach that the brightener is a compound having the general formula  $R'-S-R-SO_3X$  as is presently claimed.

Dahms et al teach (see abstract, col. 4, lines 5-45 and col. 6, lines 9-20) a preferred embodiment for the electroplating of copper using sodium 3-mercaptopropane-1-sulfonate ( $\text{HS}(\text{CH}_2)_3\text{SO}_3\text{Na}$ ) and that the divalent sulfur compound allows for high brightness deposition of copper which is free from haze.

Therefore, it would have been obvious to one of ordinary skill in the art to have used the sodium 3-mercaptopropane-1-sulfonate of Dahms et al for the organic brightener of Lyde because Dahms et al teach that the divalent sulfur compound improves brightness and produces a copper electrodeposit free from haze.

Regarding claim 141, the sodium 3-mercaptopropane-1-sulfonate ( $\text{HS}(\text{CH}_2)_3\text{SO}_3\text{Na}$ ) has a molecular weight of 170.

Regarding claims 142-149, Lyde teaches adding the brightening agent at more than 1 mg/L. This includes the entire claimed range. It would have been obvious to one of ordinary skill in the art to have increased the amount of brightener to have optimized the improved inhibition of step plating and leveling power.

Regarding claim 153, while Lyde does not expressly teach electrically attaching the silicon wafer to the cathode, due to the underlying electrochemical reaction, the wafer is inherently connected to the cathode. This is also shown to be well known in the art by other art of record.

13. Claims 133 and 134 are rejected under 35 U.S.C. 103(a) as being unpatentable over (1) Dubin et al or (2) Uzoh or (3) Dahms et al in view of Dubin et al or (4) Lyde in view of Dubin et al as applied to claim 124 above, and further in view of Bernards et al (US 5,068,013).

The teachings of Dubin et al, Uzoh, Lyde or Dahms et al are described above.

None of Dubin et al, Uzoh, Lyde or Dahms et al teach using suppressor agent, such as a polyether in the electroplating solution.

Bernards et al teach (see paragraph spanning cols. 2 and 3 and col. 4, lines 31-45) adding a polyether surfactant to a copper plating solution to improve the throwing power of the solution (i.e.-improved even plating in high aspect ratio through holes (see discussion at col. 1, line 29 to col. 2, line 35).

Therefore, it would have been obvious to one of ordinary skill in the art to have added the polyether surfactant as a suppressor agent to the prior art copper plating solutions because Bernards et al teach that the polyether surfactant has the ability to improve even plating in high aspect ratio features.

14. Claim 140 is rejected under 35 U.S.C. 103(a) as being unpatentable over (1) Dubin et al in view of Dahms et al or (2) Uzoh in view of Dahms et al or (3) Dahms et al in view of Dubin et al or (4) Lyde in view of Dubin et al and Dahms et al as applied to claim 137 above, and further in view of Bernards et al (US 5,051,154).

The teachings of Dubin et al, Uzoh, Lyde or Dahms et al are described above.

None of Dubin et al, Uzoh, Lyde or Dahms et al teach using a bis-sulfopropyl disulfide compound as the brightener.

Bernards et al teach (see col. 6, lines 29-37) using a bis-sulfopropyl disulfide as a brightener.

Therefore, it would have been obvious to one of ordinary skill in the art to have used the bis-sulfopropyl disulfide compound of Bernards et al as the brightener of Dubin

et al, Uzoh, Dahms et al or Lyde because the bis-sulfopropyl disulfide is a conventional brightener in copper electroplating that improves throwing power (see col. 5, line 49 to col. 6, line 13, esp. col. 6, lines 5-10) of the electroplating, thus making plating in vias and trenches more even.

15. Claims 150 and 151 are rejected under 35 U.S.C. 103(a) as being unpatentable over (1) Dubin et al in view of Dahms et al or (2) Uzoh in view of Dahms et al or (3) Dahms et al in view of Dubin et al or (4) Lyde in view of Dubin et al and Dahms et al as applied to claim 137 above, and further in view of Bernards et al (US 5,068,013).

The teachings of Dubin et al, Uzoh, Lyde or Dahms et al are described above.

None of Dubin et al, Uzoh, Lyde or Dahms et al teach using suppressor agent, such as a polyether in the electroplating solution.

Bernards et al teach (see paragraph spanning cols. 2 and 3 and col. 4, lines 31-45) adding a polyether surfactant to a copper plating solution to improve the throwing power of the solution (i.e.-improved even plating in high aspect ratio through holes (see discussion at col. 1, line 29 to col. 2, line 35).

Therefore, it would have been obvious to one of ordinary skill in the art to have added the polyether surfactant as a suppressor agent to the prior art copper plating solutions because Bernards et al teach that the polyether surfactant has the ability to improve even plating in high aspect ratio features.

### ***Response to Arguments***

16. Applicant's arguments with respect to claims 124-137 and 140-153 have been considered but are moot in view of the new ground(s) of rejection.

**Conclusion**

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Harry D Wilkins, III whose telephone number is 571-272-1251. The examiner can normally be reached on M-Th 10:00am-8:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Roy V King can be reached on 571-272-1244. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Harry D Wilkins, III  
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